Abstract

A novel nanoscale grasping device comprising at least three electrostatically actuated grasping elements is disclosed. The use of at least three elements, which together define a plane, allows an object to be grasped more accurately, more easily held in a defined location or orientation, and more readily manipulated. The grasping elements preferably comprise conductive nanotubes which are grown at specific points on a substrate (e.g., directly on an electrode), using chemical vapor deposition ("CVD") techniques, thereby allowing the grasping device to be manufactured with greater control. Different types of electrostatic forces may be used to open or close the grasping tool. Such attractive and repulsive forces can be created through the application of either a constant voltage or an oscillating voltage. By changing the phase of the oscillating voltage on each grasping element, the attractive and repulsive forces between multiple grasping elements can be controlled so as to cause the opening or closing of the grasping

elements. Additionally, the magnitude of the DC or oscillating voltage can be adjusted so as to alter the attractive forces created between the grasping elements. And in the case of the oscillating voltage, the frequency or speed at which the phases transform can be altered so as to adjust the gripping action between the various grasping elements. Additionally, the frequency or speed at which the phases transform can be altered so as to cancel or enhance resonant thermal or mechanical vibration of the nanotubes.

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